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## NOTE

This book deals with the fundamental aspects of the chemistry and technology of destructive hydrogenation of solid and liquid fuels; the effects of temperature, pressure, catalysts, and solvents on the process of destructive hydrogenation; and the conversion of hydrogenation products into high-quality gasolines.

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The book has been accepted [by the Ministry of Higher Education USSR] as a text for students of higher educational institutions of the petroleum and chemical industries and may be used as a manual by engineers who are active in the field of fuel conversion -- N. M. Karavayev, Corresponding Member of Academy of Sciences USSR; Professor A. I. Bashkirov, Doctor of Technical Sciences, and Professor S. N. Obryadchikov, Doctor of Technical Sciences.

Five thousand copies of this edition have been printed.

#### INTRODUCTION [DIGEST]

First thermal cracking and then catalytic cracking permitted sharp increases in the yield of gasoline produced from crude petroleum. However, only the application of destructive hydrogenation brought the yield of gasoline produced from petroleum and petroleum residues up to almost 80%. Together with the increased extent of conversion, the quality of the gasoline was improved. Gases obtained in connection with petroleum conversion and refining became a raw material for the production of high-octane components by the methods of alkylation and selective polymerization. Further growth of the demand for gasoline led to the utilization of fossil combustibles (particularly coal) as a raw material for the production of synthetic liquid fuels.

Among fossil combustibles there are some which upon heating to 600° C in the absence of air form 10 to 40% of tar resembling petroleum to a greater or lesser degree. This method of obtaining primary tar, referred to as semicoking of coal, represents the original basis for the production of synthetic liquid fuel from coal. The primary tars were first subjected to fractionation; then, to increase the yield of gasoline, they were in addition, cracked. However, the chemical composition of the tars precluded adequate production of gasoline from them by means of distillation and cracking exclusively. Only the application of destructive hydrogenation permitted a complete conversion of the tars into motor fuel and gas. By applying the latter process, the yield of motor fuel could be raised to 75-80% with reference to the crude material.

Further development of the chemical conversion of coal proceeded along the line of direct destructive hydrogenation of coal as such. The hydrogenation of coal results in yields of 60% of gasoline, 30% of gas, 5% of water, and only 5% of unreacted organic residue of coal. The gasoline obtained by hydrogenation of coal is then subjected to aromatization. On the basis of the gas obtained as a by-product of coal hydrogenation and under utilization of petroleum-refining gases, a new industry supplying chemicals and high-octane components of fuel has been built up. Blending of aromatized hydrogenation gasolines (or of gasolines derived from petroleum) with high-octane components results in high-octane gasolines of grades 100/130, 115/160, and higher.

At present, production of high-quality aviation fuel is based on the chemical conversion of both petroleum and coal. The most perfect conversion of coal and residues of petroleum and tar into high-quality motor fuel is achieved by the method of destructive hydrogenation.

As distinguished from "gidrirovaniye," which is addition of hydrogen, destructive hydrogenation (gidrogenizatsiya) comprises both addition of hydrogen and cracking under high hydrogen pressure and in the presence of catalysts. Independently of the type of crude material used and the content of sulfur in it, hydrogenation permits the production of gasolines of varying specific quality with the desired vapor pressure and distillation curve. Sulfur compounds are practically absent in the resulting gasolines. Due to the flexible

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nature of the hydrogenation process, one can, depending on the crude material used, produce automobile gasoline, phenols, diesel fuel, furnace fuel, and other products as well as aviation gasoline.

The total capacity of hydrogenation plants in all countries corresponds to an output of approximately 6,500,000 tons per year. A considerable amount of experimental and practical data on the subject of hydrogenation of fuels has been accumulated by scientific research institutions and the industry and these data have been utilized as fully as possible in writing this text.

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